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INTERNATIONAL APPLICATION NO.

PCT/EP00/06993

ATTORNEY'S DOCKET NUMBER

091395/9206

21. ☒ The following fees are submitted:
BASIC NATIONAL FEE (37 CFR 1.492(a) (1) - (5)):
 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040.00
 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890.00
 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740.00
 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710.00
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CALCULATIONS PTO USE ONLY

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Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	11 - 20 =	0	x \$18.00
Independent claims	1 - 3 =	0	x \$84.00
			+ \$280.00

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TOTAL OF ABOVE CALCULATIONS =

\$890.00

☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.

\$

SUBTOTAL =

\$

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

\$

TOTAL NATIONAL FEE =

\$

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$ 40.00

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a. ☒ A check in the amount of \$ 930.00 to cover the above fee is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

David B. Smith

NAME

27,595

REGISTRATION NUMBER

Express Mail Label No. EL6712588681US

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date of my signature and is addressed to Box PCT, Assistant Commissioner for Patents, Washington, D.C. 20231.

John W. Anderson 3/5/2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re

International Application of

Dietmar Weissflog

U.S. National Phase of
International Application No.
PCT/EP00/06993International Filing Date:
21 July 2000

SEPARATOR FOR AN AXIAL ACTUATOR

PRELIMINARY AMENDMENTBOX PCT
Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Please amend the application as follows prior to calculation of the filing fees.

IN THE CLAIMS

1. (Amended) A separator for axial actuators including two positioner rings comprising at least three pairs of spiral raceways each movable contrary to the other, the separator comprising three spacers at least spirally interconnected to comply with the shape of the raceways in reducing the friction between said positioner rings, whereby rotation of one positioner ring results in axial motion of the other positioner ring.
2. (Amended) The separator as set forth in claim 1 wherein said spacers are made of a friction-reducing material.

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3. (Amended) The separator as set forth in claim 2, comprising

- a) three spiral surfaces each describing a circular arc of approx. 120° in roughly the width of said raceways and
- b) at least one cylindrical sleeve,
- c) whereby said spiral surfaces are secured to the inner or outer circumference of said at least one cylindrical sleeve.

4. (Amended) The separator as set forth in claim 2, comprising

- a) three spiral surfaces each describing a circular arc of approx. 120° in roughly the width of said raceways and
- b) two cylindrical concentric sleeves differing in diameter,
- c) whereby said spiral surfaces are secured between said cylindrical sleeves.

6. (Amended) The separator as set forth in claim 1 wherein said spacers comprise

- a) a cage complying to said three spirally ascending spiral surfaces each describing a circular arc of approx. 120° in roughly the width of said raceways,
- b) said cage comprising rolling elements conventionally connected thereto.

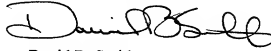
10. (Amended) The separator as set forth in claim 2 wherein said friction-reducing material is a bronze alloy or a plastics material.

11. (Amended) The separator as set forth in claim 6 wherein said rolling elements are rollers or needles.

REMARKS

The claims have been substituted to remove multiple dependent claims and to conform to U.S. Patent Office practice. Please enter this amendment before calculating the filing fees.

Respectfully submitted,



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File No. 091395/9206

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Version With Markings to Show Changes Made

1. (Amended) A separator for axial actuators including two positioner rings comprising at least three pairs of spiral raceways each movable contrary to the other, the separator comprising three spacers [(4A, 4B, 4C)] at least spirally interconnected to comply with the shape of the raceways in reducing the friction between said positioner rings[(10, 12)], whereby rotation of one positioner ring results in axial motion of the other positioner ring.

2. (Amended) The separator as set forth in claim 1 wherein said spacers [(4A, 4B, 4C)] are made of a friction-reducing material.

3. (Amended) The separator as set forth in claim 2, comprising

- a) three spiral surfaces [(4A, 4B, 4C)] each describing a circular arc of approx. 120° in roughly the width of said raceways and
- b) at least one cylindrical sleeve[(6)],
- c) whereby said spiral surfaces are secured to the inner or outer circumference of said at least one cylindrical sleeve[(6)].

4. (Amended) The separator as set forth in claim 2, comprising

- a) three spiral surfaces [(4A, 4B, 4C)] each describing a circular arc of approx. 120° in roughly the width of said raceways and
- b) two cylindrical concentric sleeves [(6, 6A)] differing in diameter,
- c) whereby said spiral surfaces [(4A, 4B, 4C)] are secured between said cylindrical sleeves [(6, 6A)].

6. (Amended) The separator as set forth in claim 1 wherein said spacers [(4A, 4B, 4C)] comprise

a) a cage complying to said three spirally ascending spiral surfaces each describing a circular arc of approx. 120° in roughly the width of said raceways,

b) said cage comprising rolling elements conventionally connected thereto.

10. (Amended) The separator as set forth in [any of the] claim[s] 2 [to 5] wherein said friction-reducing material is a bronze alloy or a plastics material.

11. (Amended) The separator as set forth in [any of the] claim[s] 6 [to 9] wherein said rolling elements [(8)] are rollers or needles.

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Separator for an Axial Actuator

Description

The present invention relates to a separator for axial actuators including two positioner rings comprising at least three pairs of spiral raceways, each movable contrary to the other. Axial actuators/positioners making use of the cited separators find application, for example, in gears, brakes, clutches, differential locks, clamps, presses, and the like.

Known from DE 24 57 886 B1 is a means for relative axial motion of two shaft parts in which a dynamic axial motion is achieved for producing a cyclic axial stroke by a rotating shaft, whereby the axial stroke can be optionally coupled out of engagement. In all example embodiments of this means includes only one rolling element and one or more spiral raceways on only one side part, each of which represents the function of a control cam for determining the timing factor for the stroke. Differingly controlling the relative axial motion of the two shaft parts as described in DE 24 57 886 B1 is achieved in that either the one or the other spiral raceway is employed to permit application of different pitches in each case for various applications. Thus, this known means is not an axial actuator in a strict sense and thus fails to touch upon the problem of reduced friction motion of positioner rings of an axial actuator.

Axial actuators/positioners are used when a rotary motion needs to be converted in a linear motion also in a very restricted space environment and involving high forces. Axial actuators feature spiral raceways facing each other, arranged in the region of a cylindrical shell surface about a longitudinal centerline of the cylinder, i.e. each raceway being actually a wedge "wrapped around" a longitudinal centerline, so-to-speak. Moving the wedges counterwise, i.e. in this case counter-rotating the two positioner rings of the axial actuator, results in each positioner ring being moved relative to the other in being moved towards each other or away from each other in the direction of the longitudinal centerline of the axial actuator. In this arrangement, a small rotation over the wedge surface of the spirals achieves an axial motion which is provided as a stroke or switching motion for one of the

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devices as cited above. In one embodiment of an axial actuator having a train of stepped or sawtooth-shaped raceways there is the problem of finding suitable separators permitting communication of the usually very high force associated with axial actuators via the positioner rings with minimum friction.

To reduce the friction between positioner rings of axial actuators a lubricant, for example graphite or a highly viscous grease is used as a rule. Positioner rings are often made also of bronze alloys or the like to ensure certain emergency running properties for "tired" lubricants. Although for best cost-effectiveness it would appear good practice to use pasty, liquid or powdery lubricants, this has the disadvantage that ensuring reliable, safe operation of an axial actuator necessitates complicated regular servicing which, however, in many applications of such axial actuators is practically unfeasible and thus undesirable. This is why means have been sought to permit reliable operational readiness of axial actuators.

It is an objective of the invention to provide a separator for axial actuators comprising a train of spiral raceways which is easy to produce and which greatly reduces the friction between the positioner rings.

This objective is achieved by a separator as set forth in claim 1. The separator in accordance with the invention comprising spirally interconnected spacers, complying with the shape of the raceways, reliably prevent the two positioner rings directly coming into contact with each other. Because the spacers reduce the friction between the positioner rings, the emergency running properties between the positioner rings is substantially better than that of prior art axial actuators. When the separators are made of a friction-reducing material, which is naturally softer than the positioner rings of the axial actuator, they or their contours are able to contact the separator of a friction-reducing material with high pressure in communicating forces with near-zero friction. In one example embodiment of the invention the spiral surfaces are integrally connected to a cylindrical sleeve roughly in the width of the positioner ring raceways. The cylindrical sleeve is guided cylindrically centered by suitable means of the axial actuator. To achieve additional radial guidance of each positioner ring relative to the other, sleeves of the same friction-reducing material as the spacers may be provided at the inner and outer circumferences of the spiral surfaces of the separator in accordance with the invention.

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In another advantageous further embodiment of the invention the spacers may be configured like a rolling element cage complying with the same spiral configuration as described above, but comprising rolling element pockets carrying rolling elements protruding beyond the axial definition of the spiral surfaces and which communicate the forces to be handled in operation of the axial actuator axially including rolling friction. Here too, the spacers to be termed spiral cages may be correspondingly located via inner and/or outer radial retaining sleeves. The spacers as described above of a friction-reducing material as well as the spacer described thereafter as a spacer cage carrying rolling elements may be configured in a further advantageous embodiment so that each of the spiral surfaces is connected by its upper end to the lower end of the adjoining spiral surface via the step heel inbetween in thus eliminating the need for the sleeves as described above. This may be of advantage in the one or other embodiment.

Further advantages and features of the invention read from the sub-claims. The invention will now be detailed by way of an example with reference to the drawings in which:

- Fig. 1 is a greatly diagrammatic axial view of a separator in accordance with the invention.
- Fig. 2 is an elevation of the separator as shown in Fig. 1.
- Fig. 3 is section taken along the line A-A of the separator as shown in Fig. 1.
- Fig. 4 is a greatly simplified diagrammatic view of how two positioner rings are assigned in an axial actuator.
- Fig. 5 is an illustration of various example aspects of the separator in accordance with the invention.
- Fig. 6 is an illustration of a further example embodiment of a separator in accordance with the invention.
- Fig. 7 is a diagrammatic illustration of one example of a separator in accordance with the invention including spacers carrying the rolling elements.
- Fig. 8 is an illustration of further example aspects of a separator in accordance with the invention including rolling elements and radially centering

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sleeves.

Fig. 9 is an illustration of a further example aspect of the separator in accordance with the invention including a spacer carrying rolling elements.

Referring now to Fig. 1 there is illustrated a separator 2 configured with three spacers 4A, 4B and 4C, each of which in this example aspect features a circular arc of approx. 120°. Diagrammatically depicted in the left-hand lower portion of the spacer 4C are two rolling elements 8 to be detailed later on. Fig. 2 is a side view of the separator 2 as shown in Fig. 1. In this illustration the spiral profile of the spacers 4A, 4B and 4C is particularly clearly evident. Indicated merely by the broken line is a sleeve 6 with which the spacers may be integrally connected. Fig. 3 illustrates the separator 2 as shown in Fig. 1 in a section taken along the line A-A. In this illustration too, the profile of the spacers 4A and 4B about the longitudinal centerline Z is particularly clearly evident. Likewise shown in an example thickness is the sleeve 6 connected to the spacers 4A, 4B and 4C as illustrated by way of example.

The separator 2 as shown in Figs. 1 to 3 is provided for an axial actuator (or positioner) having a train of three spiral raceways. In an axial actuator configured as such no breakaway torque materializes about the longitudinal centerline Z since the positioner rings of the axial actuator are integrally connected with each other in a three-point contact situation as idealized diagrammatically.

Each of the Figs. 4 to 9 as described in the following show a view which would correspond to that as viewing top-down the separator as shown in the plane of the drawing in Fig. 1. Illustrating it in this way has been chosen to simplify its depiction. Fig. 4 is a diagrammatic view of two positioner rings as 10 (upper positioner ring) and 12 (lower positioner ring). Evident between the two positioner rings is an interspace 14 packed with lubricant in prior art, which is likewise configured spiral to conform to the spiral raceways of the axial actuator. Fig. 5 shows spirally configured spacers 4B and 4C arranged to run about the sleeve 6 as already described. Also evident from Fig. 5 is a sleeve 6A depicted by the broken line which may be provided in addition to the sleeve 6 as shown. The plan view on one such sleeve 6A is likewise shown in the illustration of Fig. 1. The height H of the sleeves 6, 6A of the separator 2 as shown in Fig. 5 can be selected as a function of the expedient height of the axial actuator and

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is indicated in this case merely by way of example. Fig. 6 shows a further example aspect of a separator in accordance with the invention in which each of the spacers 4A, 4B and 4C is connected by its axially "upper" end to the "lower" end of the adjoining spiral surface via so-called heels 4Z. As evident from Fig. 6 there is no need to provide a sleeve 6 or sleeve 6A in such an embodiment.

Fig. 7 shows an embodiment of a separator in accordance with the invention as a kind of roller bearing cage in which rolling elements 8 are inserted in suitable rolling element pockets (not shown). The spacers 14A, 14B, 14C of the aspects of the separators as shown in Figs. 7 to 9 may be made of a friction-reducing material, but not necessarily so. When, however, it is possible that the diameter of the rolling elements arranged in an embodiment of the axial actuator sealed-for-life amounts to or is less than the thickness of the spacer, then it is good practice to make the spacer of a friction-reducing material so that, here too, a certain emergency running property is provided for.

The embodiments as shown in 8 and 9 correspond in principle to the embodiments as shown in Figs. 5 and 6 except for the difference that the example embodiments as shown in Figs. 8 and 9 include rolling elements 8 which, as also evident from Fig. 1, are arranged in the spacer surfaces.

As already mentioned, the spacers may be made of a friction-reducing material such as a bronze alloy or a particularly suitable plastics or some other material, e.g. metal, non-ferrous metal.

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Claims

1. A separator for axial actuators including two positioner rings comprising at least three pairs of spiral raceways each movable contrary to the other comprising three spacers (4A, 4B, 4C) at least spirally interconnected to comply with the shape of the raceways in reducing the friction between said positioner rings (10, 12), whereby rotation of one positioner ring results in axial motion of the other positioner ring.
2. The separator as set forth in claim 1 wherein said spacers (4A, 4B, 4C) are made of a friction-reducing material.
3. The separator as set forth in claim 2, comprising
 - a) three spiral surfaces (4A, 4B, 4C) each describing a circular arc of approx. 120° in roughly the width of said raceways and
 - b) at least one cylindrical sleeve (6),
 - c) whereby said spiral surfaces are secured to the inner or outer circumference of said at least one cylindrical sleeve (6).
4. The separator as set forth in claim 2, comprising
 - a) three spiral surfaces (4A, 4B, 4C) each describing a circular arc of approx. 120° in roughly the width of said raceways and
 - b) two cylindrical concentric sleeves (6, 6A) differing in diameter,
 - c) whereby said spiral surfaces (4A, 4B, 4C) are secured between said cylindrical sleeves (6, 6A).

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5. The separator as set forth in claim 2 comprising three spirally ascending spiral surfaces each describing a circular arc of approx. 120° in roughly the width of said raceways, whereby each spiral surface is connected at its upper end to the lower end of the adjoining spiral surface.
6. The separator as set forth in claim 1 wherein said spacers (4A, 4B, 4C) comprise
 - a) a cage complying to said three spirally ascending spiral surfaces each describing a circular arc of approx. 120° in roughly the width of said raceways,
 - b) said cage comprising rolling elements conventionally connected thereto.
7. The separator as set forth in claim 6 comprising
 - a) at least one cylindrical sleeve,
 - b) whereby said spiral surfaces are secured to the inner or outer circumference of said at least one cylindrical sleeve.
8. The separator as set forth in claim 6 comprising
 - a) two cylindrical concentric sleeves differing in diameter,
 - b) whereby said spiral surfaces are secured between said cylindrical sleeves.
9. The separator as set forth in claim 6 wherein each spiral surface is connected at its upper end to the lower end of the adjoining spiral surface.
10. The separator as set forth in any of the claims 2 to 5 wherein said friction-reducing material is a bronze alloy or a plastics material.
11. The separator as set forth in any of the claims 6 to 9 wherein said rolling elements (8) are rollers or needles.

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(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES
PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro



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(22) Internationales Anmeldedatum:
21. Juli 2000 (21.07.2000)

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(25) Einreichungssprache: Deutsch

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(30) Angaben zur Priorität:
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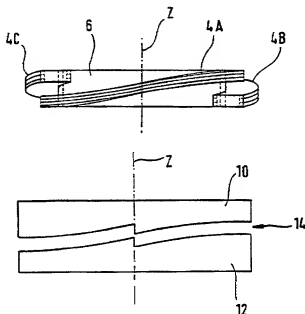
(81) Bestimmungsstaaten (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme von US): TORRINGTON NADELLAGER GMBH [DE/DE]; Werkstrasse 5, D-33790 Halle Westf. (DE).

[Fortsetzung auf der nächsten Seite]

(54) Title: SEPARATOR FOR AN AXIAL ACTUATOR

(54) Bezeichnung: ZWISCHENLAGE FÜR AXIALSTELLTRIEBE



(57) Abstract: The invention relates to a separator for axial actuators, comprising two locking rings which have at least three pairs of coil-shaped running or sliding guides that can be displaced against one another. The invention is characterised by three coil-shaped, interconnected spacers (4A, 4B, 4C) which follow the shape of the running or sliding guides and reduce the friction between the locking rings (10, 12). The spacers (4A, 4B, 4C) can consist of a lubricant substance. The separator can alternatively be configured in such a way that the spacers (4A, 4B, 4C) have a cage formed by three coil-shaped ascending coil surfaces, each describing a circular segment of approximately 120° and having the approximate width of the running or sliding guides and that said cage has rolling bodies which are connected to it in a conventional manner.

[Fortsetzung auf der nächsten Seite]

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- (84) **Bestimmungsstaaten (regional):** ARIPO-Patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), eurasisches Patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI-Patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Veröffentlicht:

— Mit internationalem Recherchenbericht.

Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

SCANNED, # 10

(57) **Zusammenfassung:** Es wird eine Zwischenlage für Axialstelltriebe mit zwei, wenigstens drei Paare gegeneinander beweglicher, wendelförmige Lauf- oder Gleitbahnen aufweisenden Stellringen vorgeschlagen, die gekennzeichnet ist durch drei wendelförmige, miteinander verbundene, der Form der Lauf- oder Gleitbahnen folgende, die Friktion zwischen den Stellringen (10, 12) verringernde Abstandhalter (4A, 4B, 4C). Hierbei können die Abstandhalter (4A, 4B, 4C) aus einem Gleitwerkstoff bestehen. Die Zwischenlage kann alternativ auch so gestaltet sein, daß die Abstandhalter (4A, 4B, 4C) einen Käfig in Form von drei wendelförmig ansteigenden, jeweils einen Kreisbogenabschnitt von etwa 120° beschreibenden Wendel-Flächen in etwa der Breite der Lauf- oder Gleitbahnen aufweisenden und den Gleitbahnen abstützenden, die U- und

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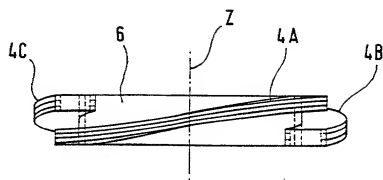


Fig. 2

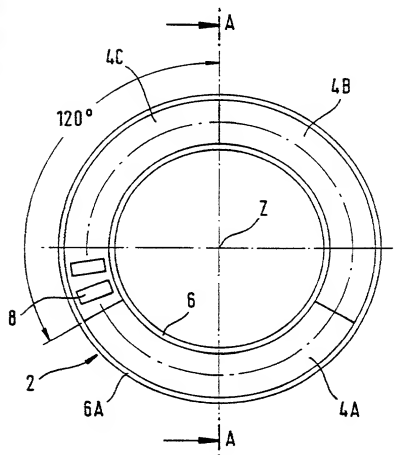


Fig. 1

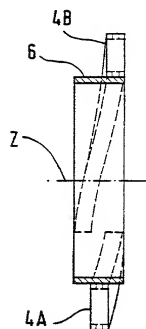


Fig. 3

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Fig. 4

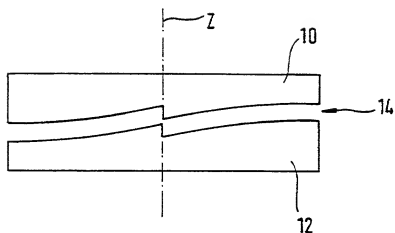


Fig. 5

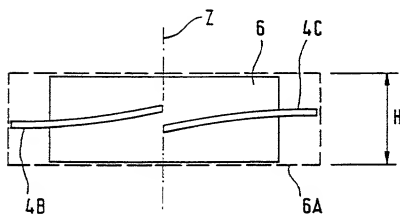
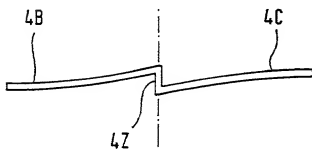


Fig. 6



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Fig. 7

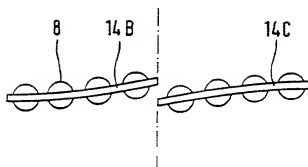


Fig. 8

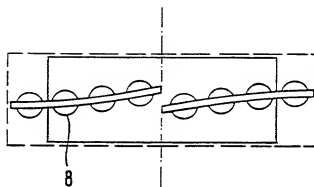
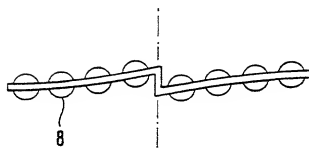


Fig. 9



Declaration and Power of Attorney For Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **SEPARATOR FOR AN AXIAL ACTUATOR** (Attorney Docket No. 091395/9206), the specification of which was filed with my authority, on July 21, 2000 as International Application No. PCT/EP00/06993.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims referred to above.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

Customer Number

23585



DIRECT ALL COMMUNICATIONS IN OR PERTAINING TO THIS APPLICATION TO:

David B. Smith
Michael Best & Friedrich LLP
3773 Corporate Parkway Suite 360
Center Valley, Pennsylvania 18034

610-798-2170

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of the foreign application for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application

19942462.4
(Number)

Germany
(Country)

6 September 1999
(Day/Month/Year Filed)

10070203.030592

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

100
Full name of inventor: Dietmar Weissflog

Inventor's signature D. Weissflog

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